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(71) Applicant: BAKER HUGHES INCORPORATED [US/US]; 3900 Essex Lane, Suite 1200, Houston, TX 77027 (US).

(72) Inventors: VINCENT, Ray, P.; 11226 Golden Ray Drive, Cypress, TX 77429 (US). KOEHRMANN, Frank; 5331 Shady Maple Drive, Kingwood, TX 77339 (US). GIVENS, George, E.; 22910 Brianhorn Drive, Spring, TX 77389 (US). KRAUSS, Christiaan, D.; 16038 Cutten Road, Houston, TX 77069 (US). WOOD, Edward, T.; 2155 Lake Village Dr., Kingwood, TX 77339 (US). MAKOHL, Friedhelm; Weesener Strasse 38, D-29320 Hermannsburg (DE). HAUGHTON, David, B.; 13606 Mansor Drive, Houston, TX 77041 (US).

(74) Agents: CARSON, Matt, W. et al.; Baker Hughes Incorporated, 3900 Essex Lane, Suite 1200, Houston, TX 77027 (US).

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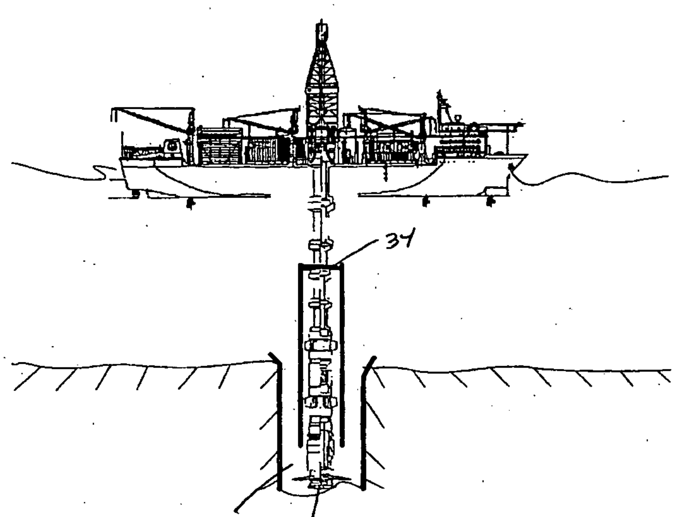
(54) Title: A ONE TRIP DRILLING AND CASING CEMENTING METHOD




(57) Abstract: A method and associated equipment are disclosed wich allow drilling at least a portion of a well and subsequently cementing casing in a single trip. The method is particularly suited for deep-water offshore operations where the drill string can be run through a section of casing leaving a bit and an under-reamer extending out below. The casing is equipped with ports through which cement can be pumped as well as an external casing packer to prevent the uncured cement in the annulus from U-tubing. Several casing sections can be run in during drilling and cemented succession using the one trip method.

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# A ONE TRIP DRILLING AND CASING CEMENTING METHOD

## PRIORITY INFORMATION

This application claims the benefit of U.S. Provisional Application No. 60/370,910 on April 8, 2002.

## FIELD OF THE INVENTION

The field of this invention is running in casing while drilling a well and cementing the casing in the same trip.

## BACKGROUND OF THE INVENTION

When drilling offshore in deep water, particularly into zones having low formation pressure from adjacent formations with higher pressure and unstable formations, there was a serious risk of collapse of the drilled hole before casing could be inserted. In the long interval between getting the drill sting out and running in casing to tie back to existing casing in the wellbore, the collapse or unstable formations in the newly drilled area would make running casing virtually impossible. The solution that was developed was to drill down just short of the pay zone and pull out of the hole with the drill sting. The casing string that was next to be secured in the well was then suspended from the floating rig. This run of casing could be almost as long as the distance from the rig floor to the seabed. The drill string would then be run through this length of casing with the lower end having an under-reamer on top of a bit extending below the suspended casing string. A mud motor was used to rotate the lower end of the drill string, while the upper end remained fixed. The fixed portion of the drill string was secured to the casing and both advanced together downhole. Drilling into the pay zone would continue until the casing got stuck due to

formation collapse around it, once the pay zone was breached. Depending on the formation characteristics of the pay zone the casing could get stuck due to borehole collapse around it as soon as a few feet after drilling into the zone. At that point the casing string was secured to the next size of casing with an external casing packer. The drill string was removed and a production string and packer were run. The last run of casing was not cemented because it couldn't be due to hole collapse around it.

It is well known that offshore deepwater rigs have very high daily rates. Accordingly, when drilling particularly in very deep water it would be advantageous to save rig time where possible.

The method of the present invention allows this to occur by making it possible to drill a portion of a well and in the same trip to cement that section of casing that is run in on the stationary portion of the drill string. In the preferred embodiment a mud motor drives an under-reamer and a bit that extend below the casing supported by the drill string. A cementing/inflation tool on the drill string engages with cementing ports in the casing to pass cement outside of the casing. The casing is secured to existing casing and the drill string is removed to complete the operation. Subsequent casing runs can be secured in the same fashion. Ultimately, a production string is secured to allow production. The process can be repeated for successive casing sizes. The process is even adaptable for use on land rigs after an initial depth is drilled, cased and cemented in the traditional manner. These and other beneficial aspects of the present invention will become more apparent to one skilled in the art from a review of the description of the preferred embodiment and the claims, which appear below.

## SUMMARY OF THE INVENTION

A method and associated equipment are disclosed which allow drilling at least a portion of a well and subsequently cementing casing in a single trip. The method is particularly suited for deep-water offshore operations where the drill string can be run through a section of casing leaving a bit and an under-reamer extending out below. The casing is equipped with ports through which cement can be pumped as well as an external casing packer to prevent the uncured cement in the annulus from U-tubing.

Several casing sections can be run in during drilling and cemented succession using the one trip method.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an offshore location showing the initial casing jetted into the seabed;

Figure 2 shows the casing suspended from the drill ship;

Figure 3 shows the drill string run through the suspended casing;

Figure 4 the casing affixed to the stationary portion of the drill string;

Figure 5 shows the application of pressure to extend the arms of the under-reamer and to start the bit turning;

Figure 6 shows drilling in progress;

Figure 7 shows the end of drilling progress as the casing suspended on the drill string lands on the previous casing string;

Figure 8 shows the drilling motor isolated and pressure buildup to open the cementing ports;

Figure 9 shows the cementing ports open;

Figure 10 shows cementing in progress;

Figure 11 shows the cementing ports isolated and the external casing packer inflated;

Figure 12 shows the dump valves open and excess cement being circulated out;

Figure 13 shows the wellbore after the drill string is removed;

Figures 14a-14b are a sectional elevation showing the casing and the drill string adjacent to it rather than inside it for greater clarity.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The method of the present invention is illustrated in Figures 1-13. Figure 1 shows a drill ship or equivalent **10** sitting on the water **12**. The seabed **14** has had initial casing **16** jetted into it leaving the beginning of a wellbore **18**.

In Figure 2, a casing string **20** is put together and supported from the drill ship **10**. The practical limit on its length is the approximate depth between the drill ship **10**

and the seabed **14**. As shown in Figure 3, the drill string **22** is run through the casing string **20** such that a bit **24** and an under-reamer **26** extend out below the lower end **28** of the casing string **20**. Ideally, the bit **24** should still clear the seabed **14** by a comfortable margin taking into account the expected wave action at the surface. A mud motor **30** drives the bit **24** and the under-reamer **26**, leaving the upper end **32** of the drill string **22** stationary.

Figure 4 illustrates that the casing string **20** is secured to the upper end **32** of the drill string **22** by a connector **34** and the assembly is lowered to get bit **24** into the wellbore **18**.

Figure 5 illustrates pressure being applied in the drill string **22**, which gets the under-reamer blades **36** to extend and starts the bit **24** turning. Figure 6 shows drilling activity as the casing **20** descends with the advance of bit **24**. Figure 7 shows the maximum possible drilling depth, which is defined as the casing **20** contacts the initial casing **16**. In view of coupling **34** connecting the drill string **22** to the casing **20**, the bit cannot advance further when casing **20** is landed on initial casing **16**.

Figure 8 shows a ball **38** dropped on a seat **40** to isolate the mud motor **30**. Straddle seals **60** and **44** surround opening **46** in the drill string **22**. Figure 9 is the view of Figure 8 with an internal sleeve that is connected to seat **40** shifted to open openings **46**. Figure 10 shows cement **48** going through an opening or openings **50** after a debris plug **52** is pushed out. Figure 11 shows a plug **54** landing on a seat **56** to isolate openings **46**. Pressure is now applied through openings **58** and between seals **60** and **42** into the external casing packer **62** to start it in its inflation cycle. Figure 12 shows external casing packer **62** fully inflated and dump valve **64** triggered open. Excess cement in the drill string **22** can now be circulated out as shown by arrows **66**. Figure 13 shows the drill string **22** removed and the casing **20** fully cemented.

The process can be repeated for subsequent runs of casing. It can also be employed with land rigs after the well is initially drilled to a given depth. The previously described assembly can be inserted into the initially drilled well. In essence, the initial wellbore substitutes for the water depth, which, in an offshore application allows the first string to be cemented **20** to be run and cemented in a single trip to the initial casing **16**. In a land rig environment, the counterpart to casing

**20** would have to be run and cemented in the known way, with further casing strings run on drill pipe and cemented in a single trip.

Referring now to Figures 14a-14b, the casing string **20** is illustrated. It has an external casing packer **62** as well as openings **50** through which cement is pumped after the optional debris plugs **52** are knocked out.

The drill string **22** is illustrated along side for clarity but it is actually assembled within casing **20**. Starting at the lower end and working uphole, the bit **24** has an under-reamer **26** above it. These two tools extend beyond the lower end **28** of the casing string **20**. Mud motor **30**, with stabilizers **68** and **70** above and below it, is mounted above the under-reamer **26**. Above the stabilizer **68** are seal assemblies **44**, **42**, and **60** respectively. They are part of an inflation/cementing tool **72**, which further includes openings **46** and **58** as well as dump valve **64**. Ball catcher sub **74** includes seat **40** (see Figure 8), which is used to isolate the mud motor **30** when ball **38** is dropped on it. Going further uphole, there are drill collars **76** and the connector **34** (see Figure 4) followed by the rest of the drill string **22** to the drill ship **10**.

The individual components are not described in detail because they are known to those skilled in the art. Rather the invention relates to the assembly of the components and the one trip method they make possible for drilling and cementing or otherwise sealing casing in a single trip. The presence of the casing during drilling also provides protection against sticking the drill string in the event of a borehole collapse. This situation is more likely to occur when drilling from a zone of higher pressure to one of significantly lower pressure or an unstable formation. The method and equipment can be used on land rigs, but the significantly higher daily rates of offshore rigs and drill ships makes the application of the method and apparatus to offshore installations more financially compelling.

The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below:

We claim:

1. A one trip drilling and casing cementing method, comprising:
providing a drilling assembly on a drill string;
supporting casing from the drill string so that said drilling assembly extends below the lower end of the casing;
lowering the drilling assembly and casing in one trip on said drill string;
drilling the well while advancing the casing;
delivering cement through at least one first opening in the casing; and
forcing the cement into the annular space between the casing and the wellbore.

2. The method of claim 1, comprising:
locating said at least one first opening in the casing wall;
advancing said drilling assembly downhole; and
supporting said casing on a non-rotating portion of the drill string.

3. The method of claim 2, comprising:
using a downhole motor to drive the drilling assembly; and
providing a drill bit and under-reamer as at least a portion of said drilling assembly.

4. The method of claim 1, comprising:
locating said at least one first opening in the casing wall;
delivering cement through at least one first opening in the wall of said drill string.

5. The method of claim 4, comprising:
delivering at least one isolator on said drill string to close an annular gap between said first opening in said drill string and said first opening in said casing wall; and
using said isolator to force cement from the drill string through said first opening in said casing wall.

6. The method of claim 5, comprising:
providing a removable plug in said first opening in said casing wall.

7. The method of claim 6, comprising:
forcing said plug out with cement.

8. The method of claim 4, comprising:
isolating said drilling assembly from pressure in said drill string;
thereafter increasing pressure in said drill string to open said first opening in said drill string wall.

9. The method of claim 8, comprising:
delivering at least one isolator on said drill string to close an annular gap between said first opening in said drill string and said first opening in said casing wall; and
using said isolator to force cement from said first opening in said drill string through said first opening in said casing wall.

10. The method of claim 9, comprising:
providing an external annulus barrier on said casing;
actuating said annulus barrier after delivery of cement from said opening in the wall of said casing.

11. The method of claim 10, comprising:
proving at least one second opening in the wall of said drill string and a second opening in the wall of said casing;
isolating an annular space between said second opening on said wall of said drill string and said wall of said casing;
actuating said external annulus barrier through said annular space.

12. The method of claim 11, comprising:

isolating said first opening in said drill string from said second opening in said drill string before actuating said annulus barrier

13. The method of claim 12, comprising:

providing a selectively opened third opening on the wall of said drill string;

raising pressure in said drill string after actuating said annulus barrier;

selectively opening said third opening with said drill string pressure; and

removing cement from said drill string.

14. The method of claim 8, comprising:

providing an annulus barrier on said casing;

actuating said annulus barrier after delivery of cement from said opening in the wall of said casing.

15. The method of claim 14, comprising:

removing cement from said drill string after actuating said annulus barrier.

16. The method of claim 15, comprising:

removing said drill string and drilling assembly from the wellbore.

17. The method of claim 16, comprising:

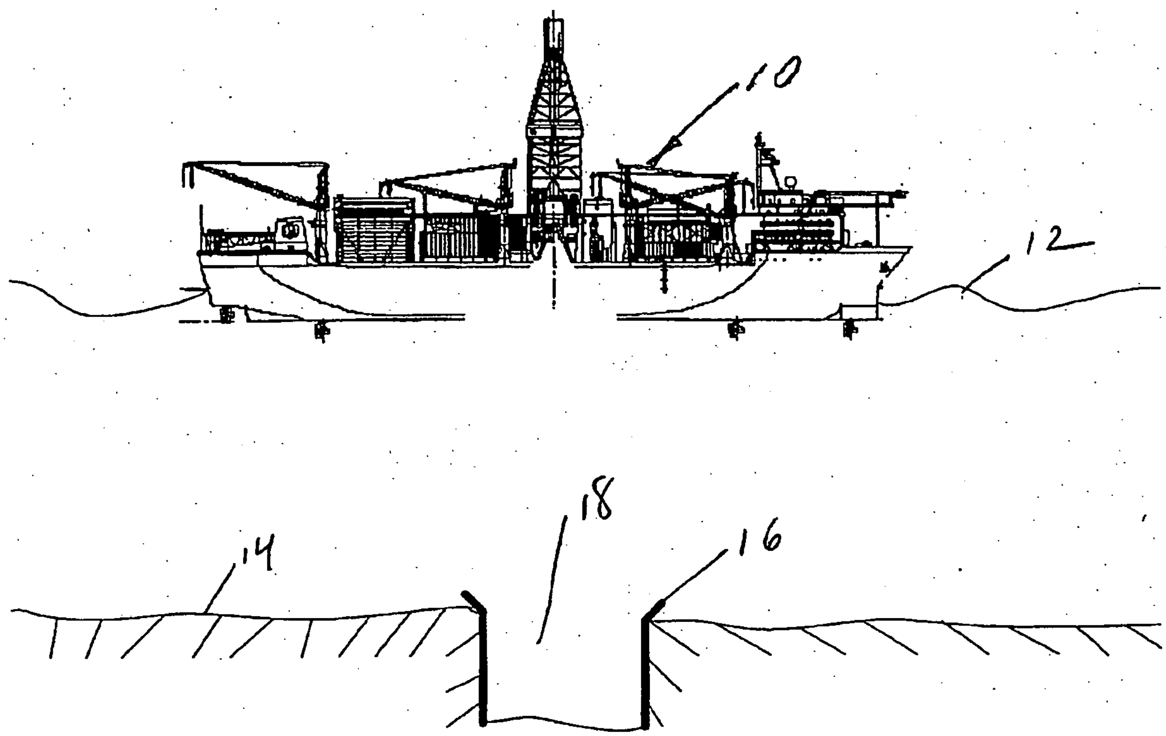
advancing said drilling assembly downhole; and

supporting said casing on a non-rotating portion of the drill string.

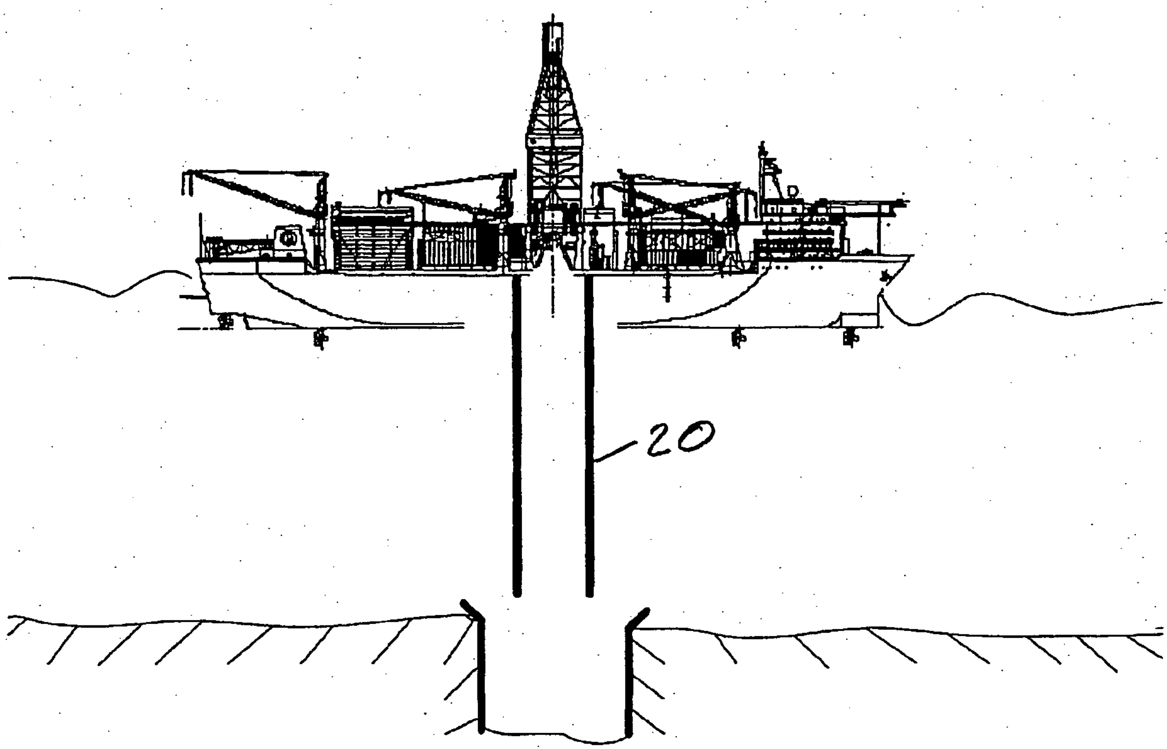
18. The method of claim 17, comprising:

using a downhole motor to drive the drilling assembly; and

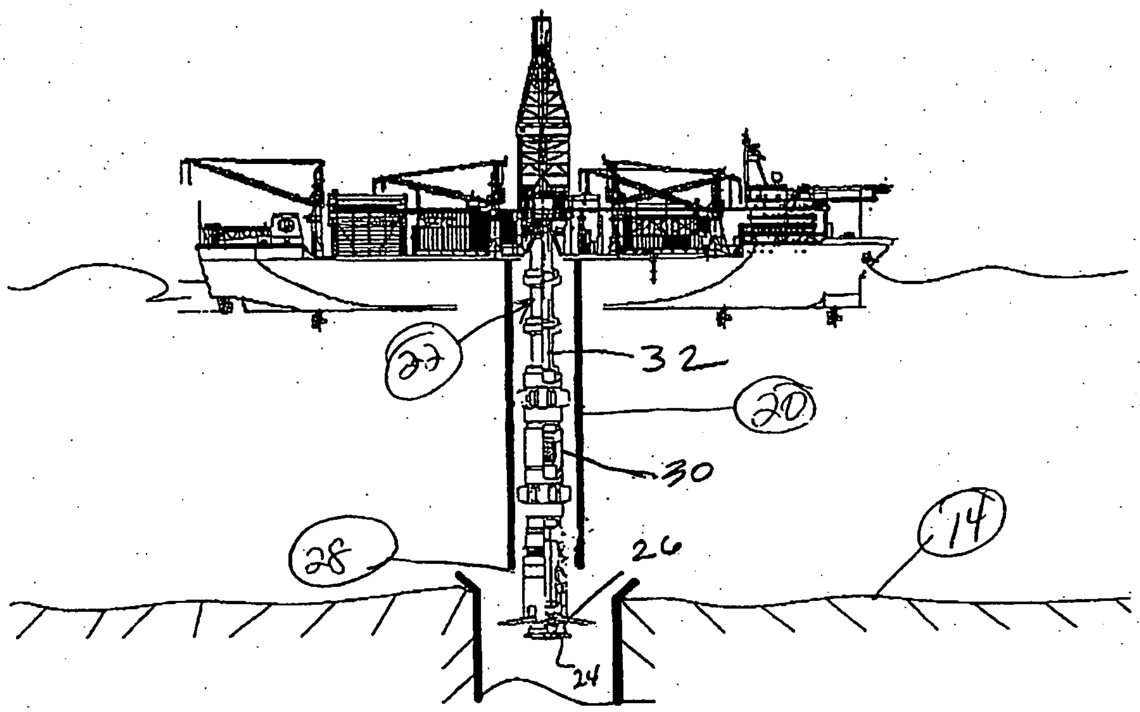
providing a drill bit and under-reamer as at least a portion of said drilling assembly.



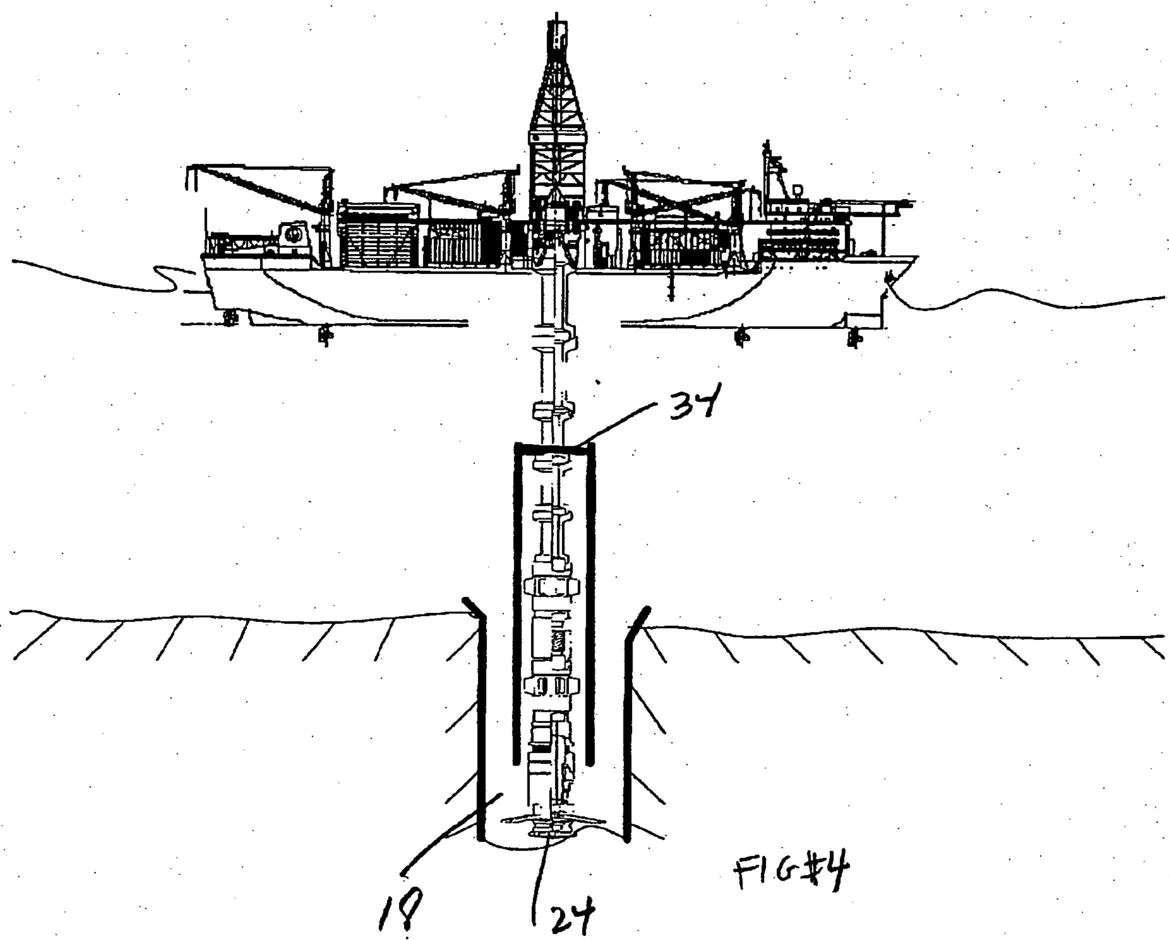

FIG#1



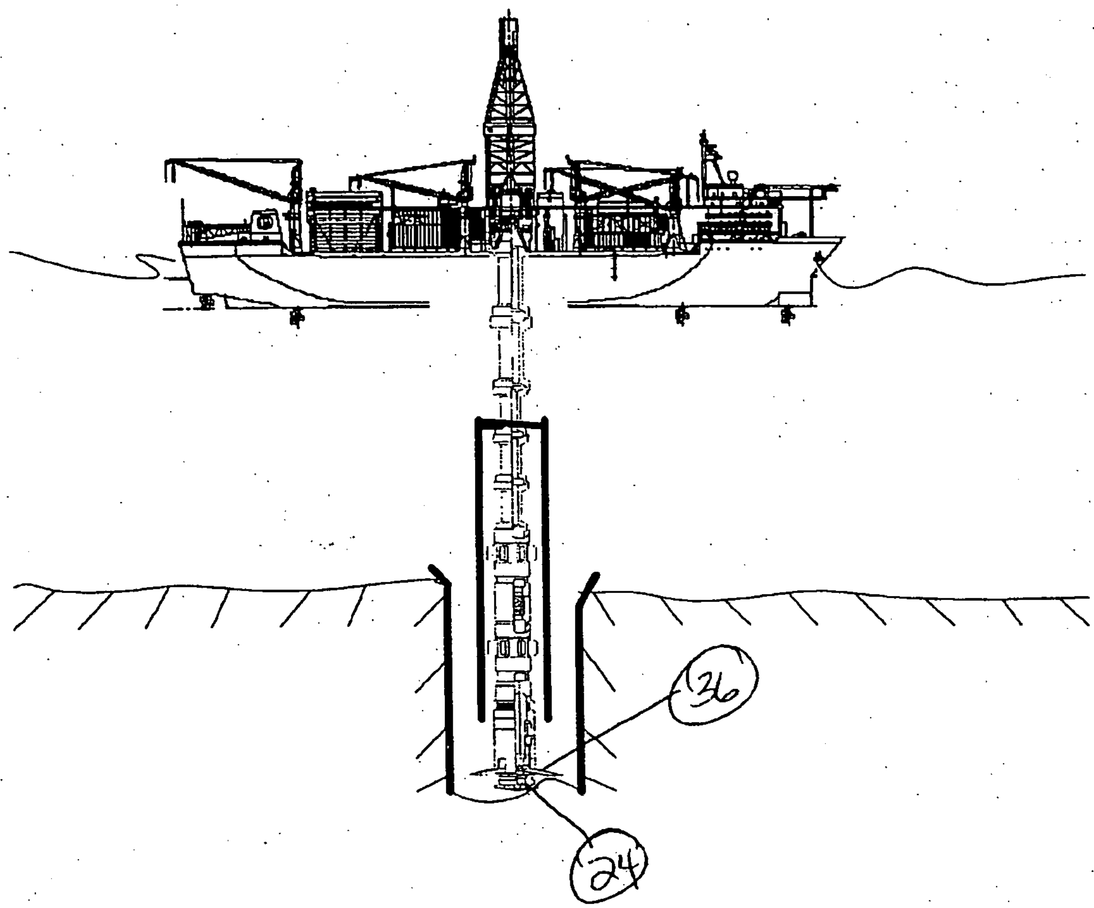

FIG#2

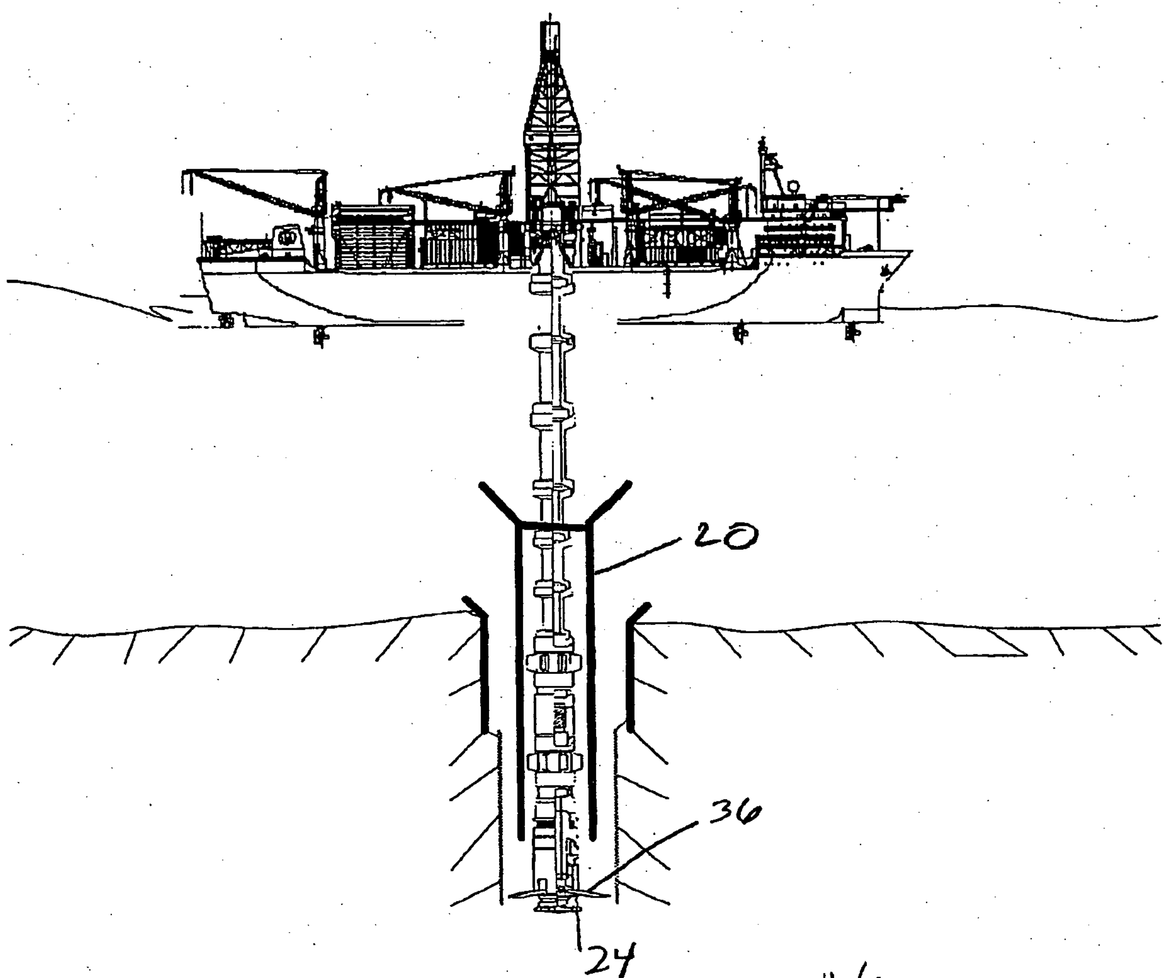



FIG#3

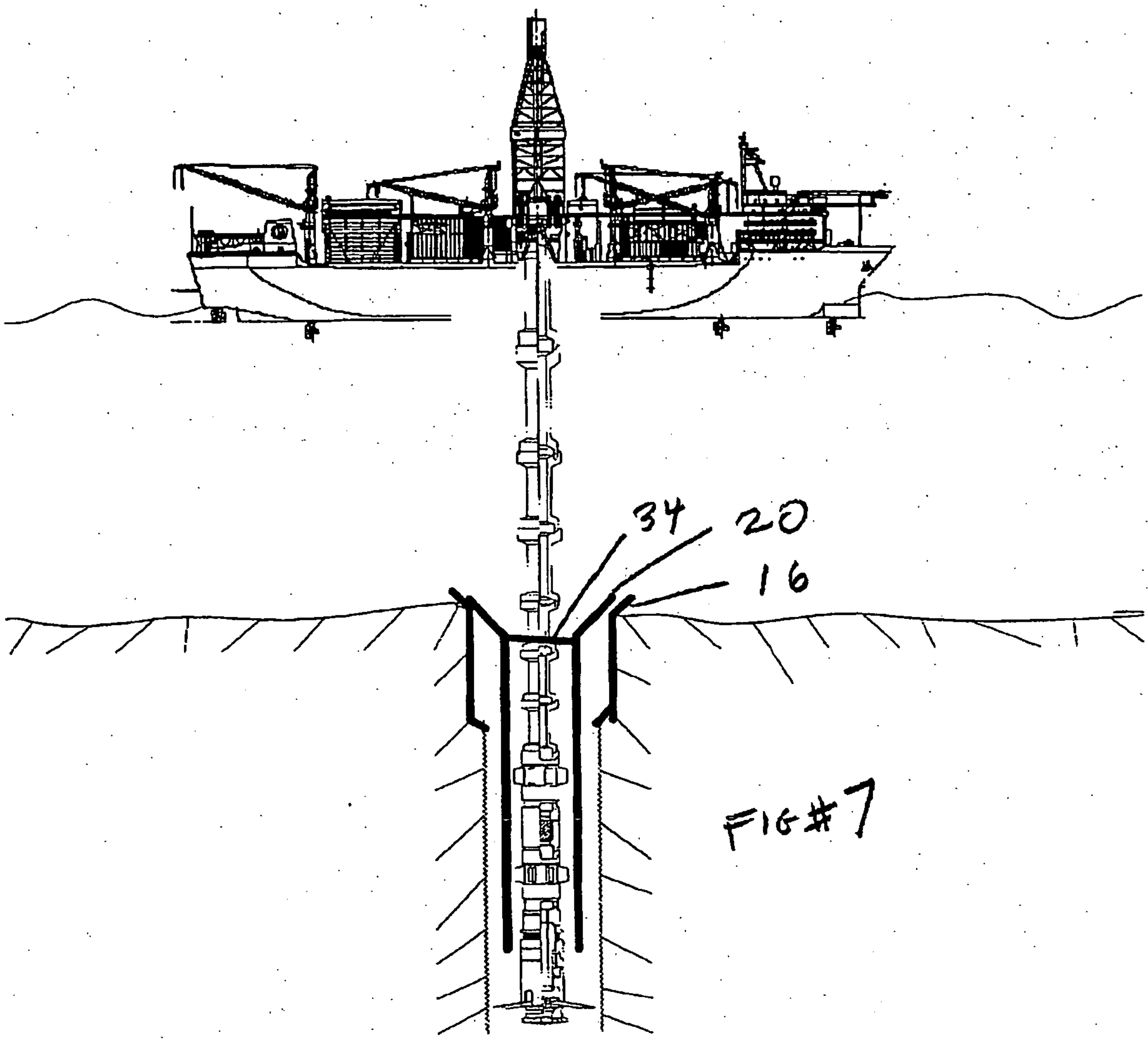



FIG#4


36
24




FIG#6




FIG#7

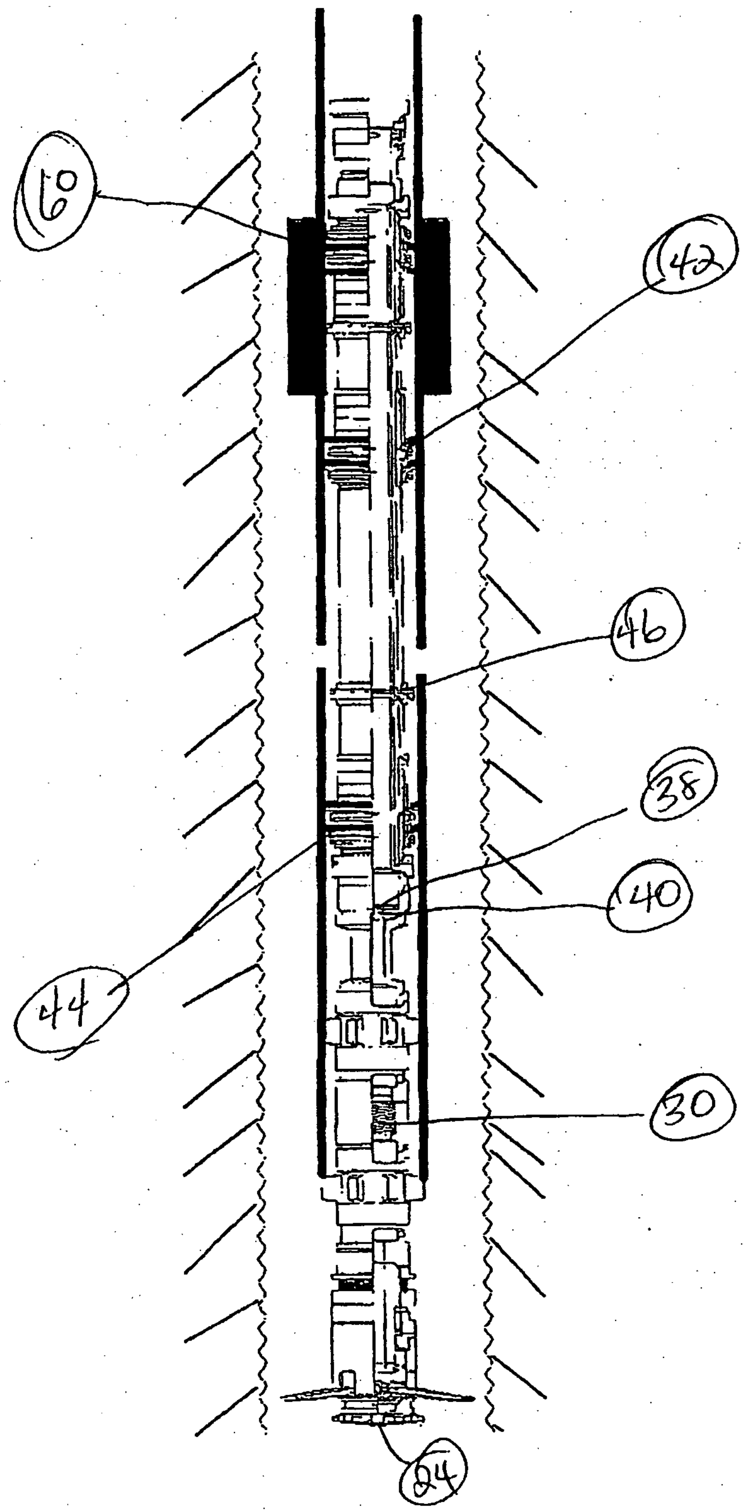



Fig 8

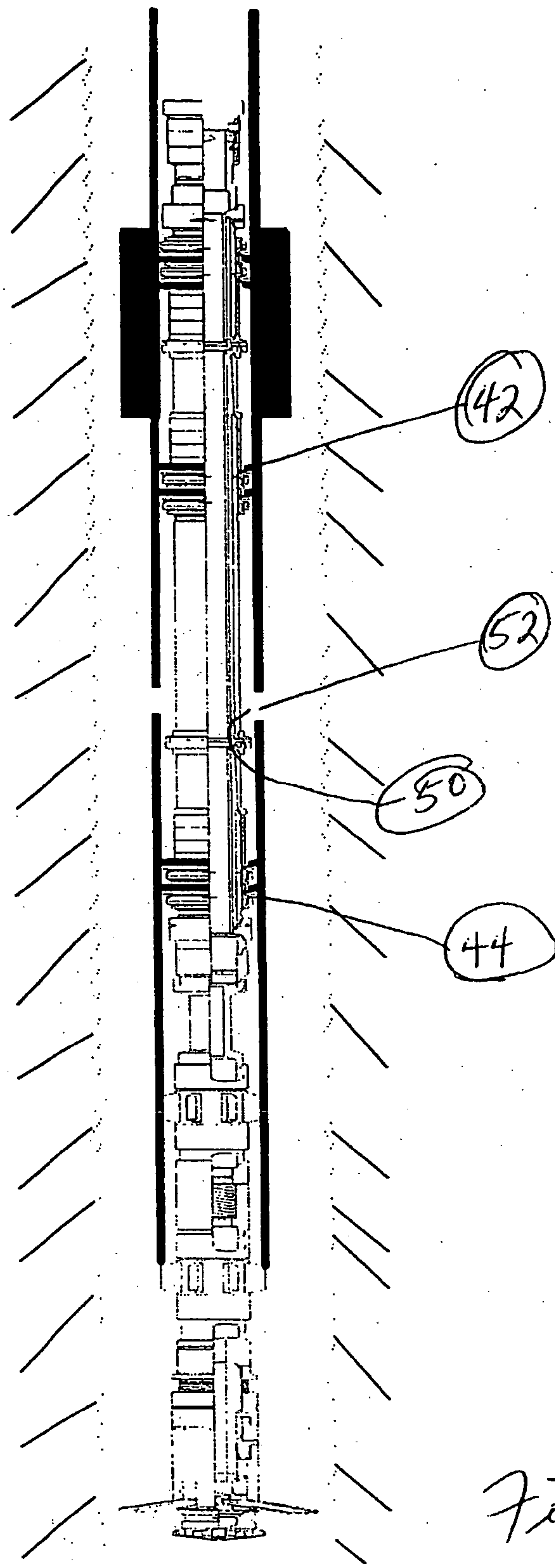



Fig 9

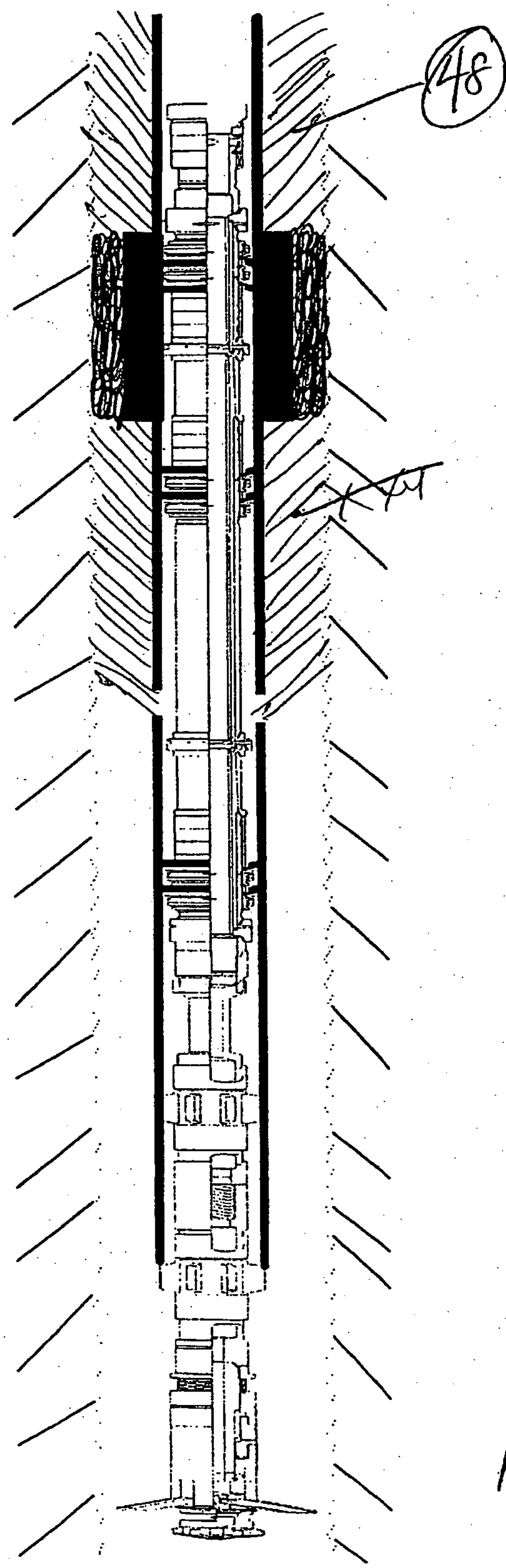



Fig 10

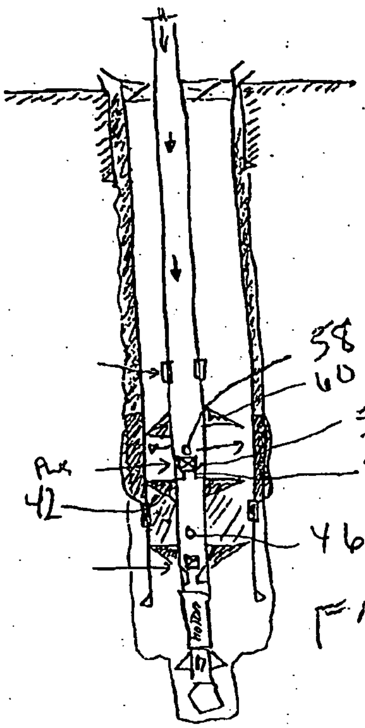



FIG #11

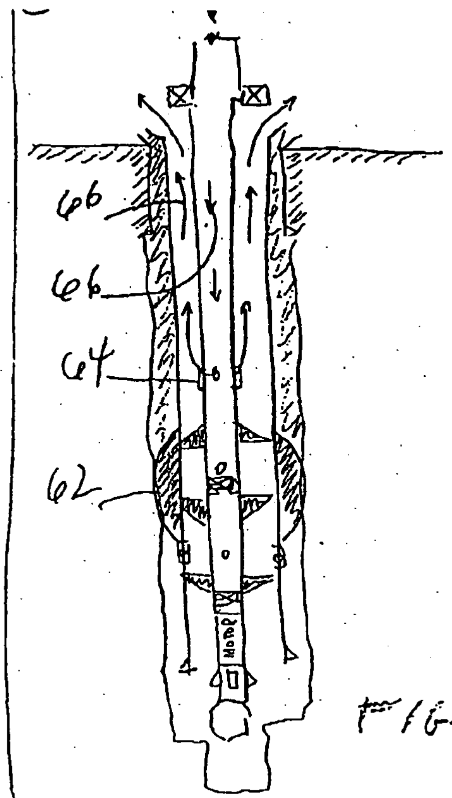



FIG #12

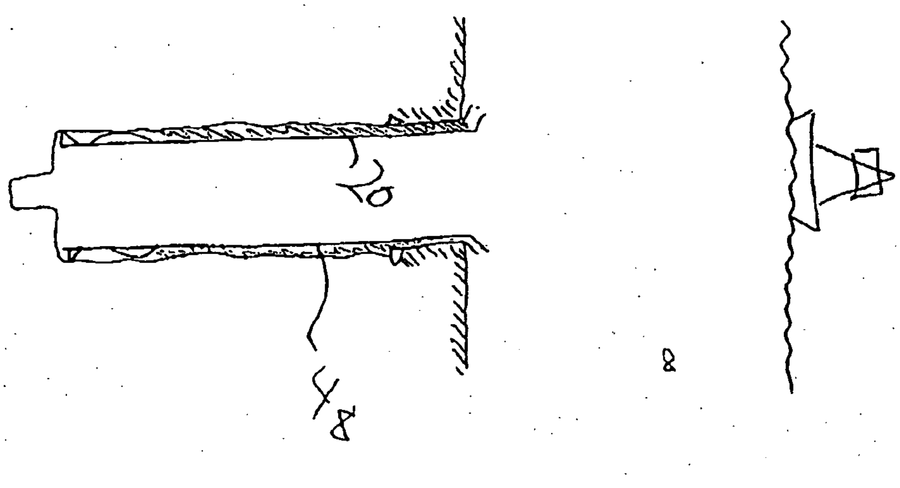



FIG #13

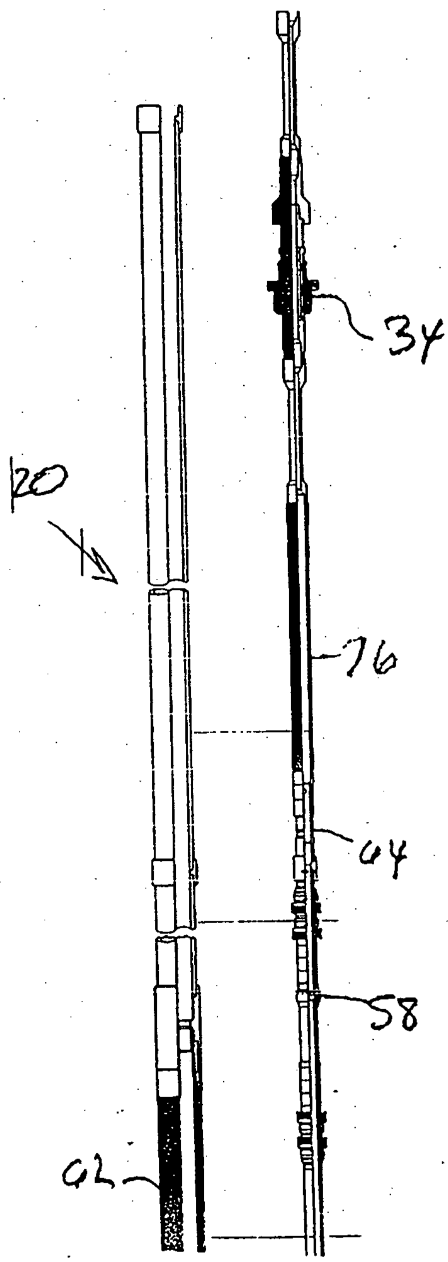
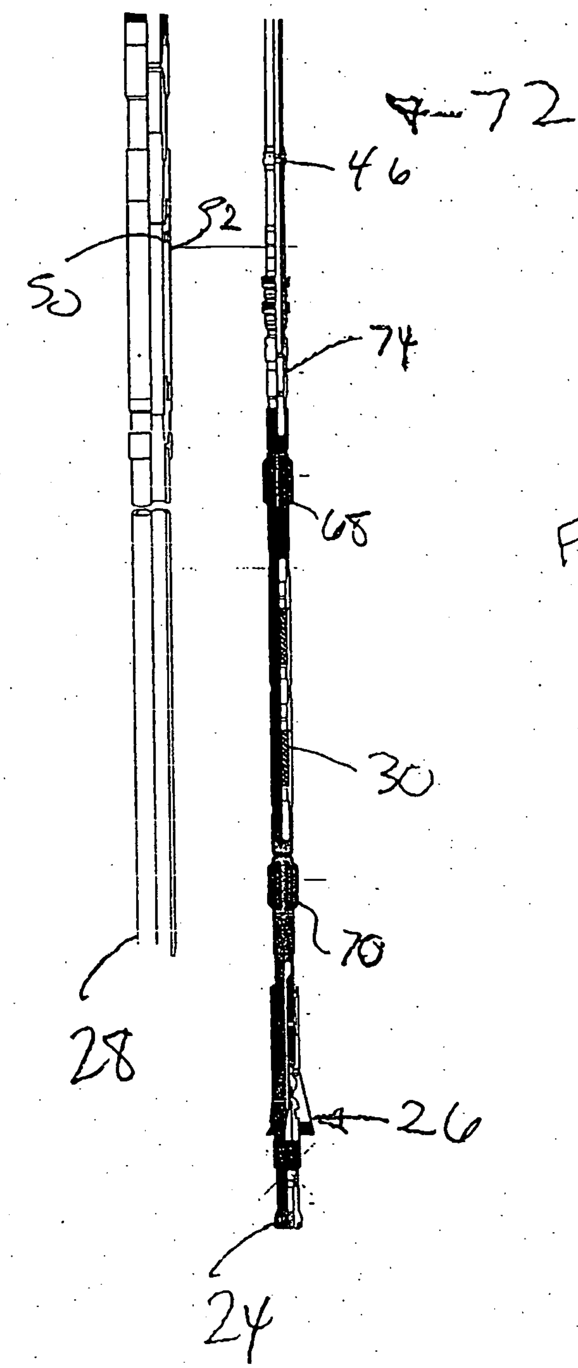



FIG #4a




FIG#14b

# INTERNATIONAL SEARCH REPORT

PCT/US 03/10324

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 E21B7/20 E21B33/14

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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| X | GB 2 010 360 A (NELSON N) 27 June 1979 (1979-06-27) page 2, column 1, line 57 -column 2, line 123 figures 1-4 --- | 1 |
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| X | US 3 984 991 A (KAGLER JR EDMOND) 12 October 1976 (1976-10-12) claim 1 figure 1 --- | 1 |

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 18 July 2003 | 28/07/2003 |

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## INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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